FIG. 1

GUI widget **105**

100

data **110**

validation object **115**

data model *120*

FIG. 2

GUI widget **105**

GUI widget **205**

100

data **110**

validation object **115**

data model *120*
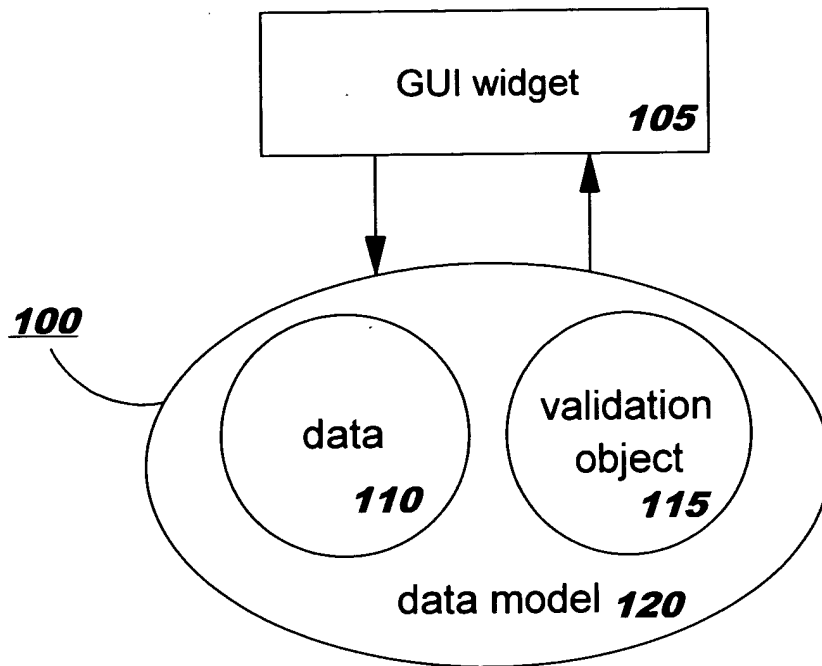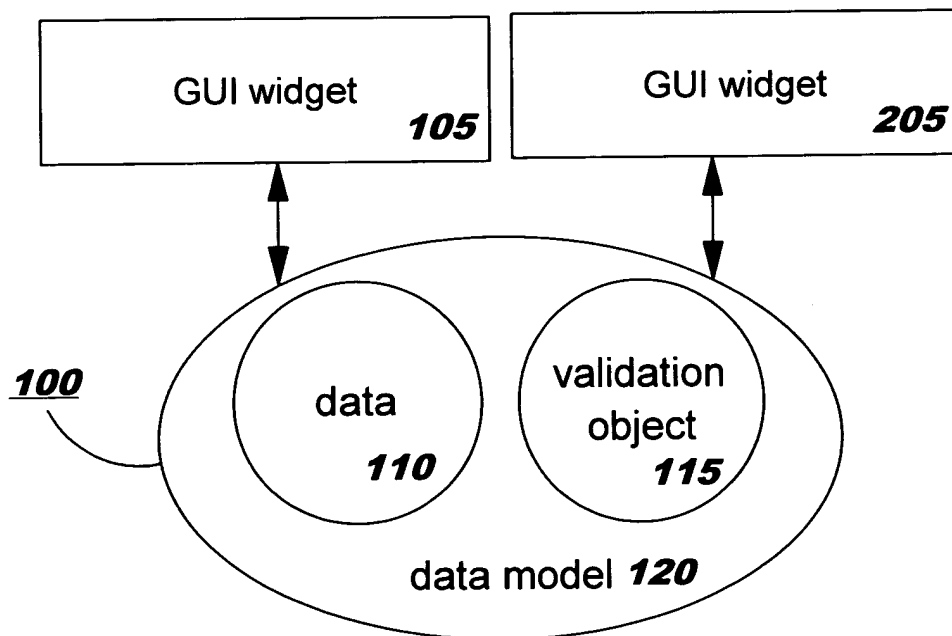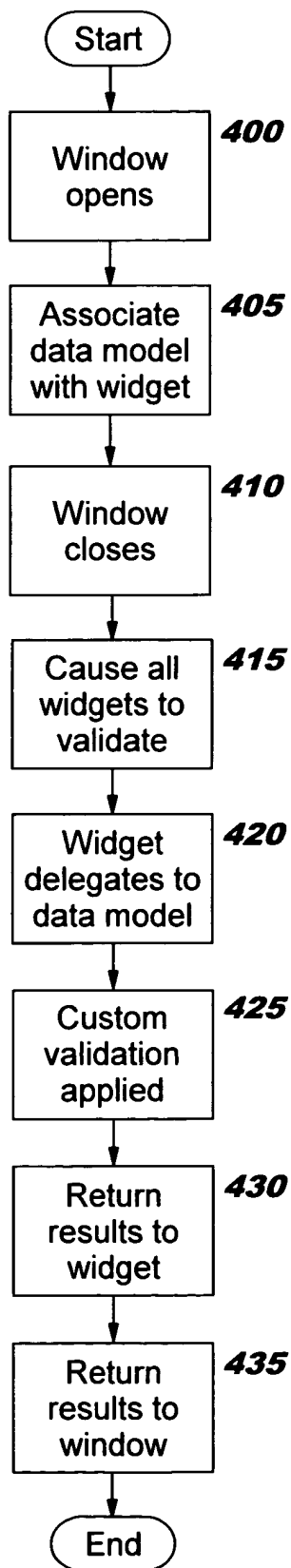
FIG. 3

300

```
305 <stringVariable
310 name="social_security_number"
315 minimumLength="9"
320 maximumLength="9">
325 <labelText>SSN</labelText>
330 <helpText>The social security number of the applicant.</helpText>
335 <mnemonic>D</mnemonic>
    <inputValidation>
      <ignore>
345     <characters>-</characters>
      </ignore>
340   <valid>
350     <characters>0123456789-</characters>
      </valid>
    </inputValidation>
  </stringVariable>
```

FIG. 4

```
            ( Start )
                |
                v
        +----------------+
        |   Window       |   400
        |   opens        |
        +----------------+
                |
                v
        +----------------+
        |  Associate     |   405
        |  data model    |
        |  with widget   |
        +----------------+
                |
                v
        +----------------+
        |   Window       |   410
        |   closes       |
        +----------------+
                |
                v
        +----------------+
        |  Cause all     |   415
        |  widgets to    |
        |  validate      |
        +----------------+
                |
                v
        +----------------+
        |   Widget       |   420
        |  delegates to  |
        |  data model    |
        +----------------+
                |
                v
        +----------------+
        |   Custom       |   425
        |  validation    |
        |  applied       |
        +----------------+
                |
                v
        +----------------+
        |   Return       |   430
        |  results to    |
        |  widget        |
        +----------------+
                |
                v
        +----------------+
        |   Return       |   435
        |  results to    |
        |  window        |
        +----------------+
                |
                v
            (  End  )
```

FIG. 5A

```
public class StringVariableModel extends VariableModel
   /**
    *  A template method which calls subclass methods (which should
    *     call super.doValidate()), then employs the Strategy pattern by calling
    *     all of the set of CustomValidators.  The first error causes the function
    *     to return.  If there is no error, then all listeners will be notified
    *     of the new value.
    */
   public boolean validate(Object value, boolean displayErrors)
   {
     String errorString;
     String strVal = (value == null) ? new String("") : value.toString();
     VariableChangedEvent vce = new VariableChangedEvent(this, strVal);

     errorString = doValidate(value, vce);
     if ((errorString == null) || (errorString.compareTo("") == 0))
     {
       Iterator it = validators.iterator();
       while (it.hasNext())
       {
         errorString = ((CustomValidator)it.next()).validate(value);
         if ((errorString != null) && (errorString.compareTo("") != 0))
           break;
       }
     }
     if ((errorString != null) && (errorString.compareTo("") != 0))
     {
       // put up a dialog or message box containing the error message.
       if (displayErrors)
       {
         JOptionPane.showMessageDialog(null, errorString, getLabelText(),
             JOptionPane.ERROR_MESSAGE);
       }
       return false;
     }
     processValueChanged(vce);
     return true;
   }
```

FIG. 5B

```
public void addValidator(CustomValidator cv)
{
  validators.add(cv);
}

public void removeValidator(CustomValidator cv)
{
  validators.remove(cv);
}
```